DAMAGE AND CONTROL OF TETRANYCHUS URTICAE IN APPLE ORCHARDS

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Abstract Tetranychus urticae, commonly referred to as the two-spotted spider mite, is one of the most economically damaging pests of agricultural and horticultural crops worldwide. Its polyphagous nature, combined with its exceptional reproductive capacity and short generation time, has contributed to its widespread distribution and pest status in both open-field and greenhouse production systems. In apple orchards, which are economically significant in Uzbekistan and many temperate regions, infestations by T. urticae lead to severe yield and quality losses through leaf chlorosis, bronzing, premature leaf abscission, and reduced fruit development. Compounding this issue is the species' well-documented ability to rapidly develop resistance to several classes of acaricides, including organophosphates, carbamates, and pyrethroids, making conventional chemical control increasingly ineffective. Consequently, there is an urgent need to implement sustainable management strategies. Integrated Pest Management (IPM) is regarded as the most effective approach to mitigating the pest's impact while preserving environmental and human health. This thesis systematically reviews the biology, damage mechanisms, and population dynamics of T. urticae, as well as its resistance development patterns, with an emphasis on Uzbekistan’s agro-ecological conditions. The study also evaluates various control methods, including chemical, biological, and cultural practices, highlighting the role of predatory mites such as Phytoseiulus persimilis and entomopathogenic fungi as key biological control agents. The findings indicate that the adoption of IPM strategies, combining selective acaricides, biological agents, and proper cultural practices, can significantly reduce mite populations and mitigate crop damage. This literature-based study aims to support the development of sustainable pest management practices suitable for apple orchards and other susceptible crops in Uzbekistan and similar agro-ecological zones.

Keywords Tetranychus urticae, two-spotted spider mite, apple orchards, IPM, biological control, chemical control

Introduction. Tetranychus urticae Koch, commonly known as the two-spotted spider mite, is one of the most notorious and economically significant pests affecting agricultural and horticultural crops worldwide. This pest is classified under the order Trombidiformes and the family Tetranychidae and is characterized by its wide host range, high reproductive potential, and ability to develop resistance to a variety of chemical control agents. Globally, T. urticae has been documented to infest more than 1,100 plant species, including vegetables, fruits, field crops, ornamental plants, and numerous greenhouse crops (Migeon & Dorkeld, 2020). The significance of T. urticae as a pest has become increasingly relevant due to changes in climate, the intensification of agricultural systems, and the extensive use of protected cultivation technologies such as greenhouses. Warmer temperatures, prolonged dry seasons, and reduced natural enemy populations have contributed to more frequent and severe outbreaks of this mite (Van Leeuwen et al., 2010). In particular, regions like Central Asia, including Uzbekistan, have reported significant infestations in apple orchards, strawberry plantations, cucumbers, cotton, and other economically important crops (NamDU, 2023). In these areas, damage is not limited to yield reduction but also affects crop quality and marketability. The feeding mechanism of T. urticae is highly destructive. The mite punctures leaf cells and sucks out their contents, causing characteristic symptoms such as chlorosis, stippling, bronzing, and premature leaf fall. In heavy infestations, mite colonies produce silk webbing, which further interferes with photosynthesis and can result in severe physiological stress and plant death (Childers & Rodrigues, 2011). Another alarming issue is the pest’s remarkable ability to develop resistance to acaricides, which has been well-documented globally (Van Leeuwen et al., 2010).

Figure.1 Panonychus ulmi Koch and Tetranychus urticae Koch

Resistance management has become a critical component of modern mite control strategies. Traditional chemical control methods, when applied alone, have proven to be unsustainable due to resistance build-up, negative effects on non-target organisms, and environmental contamination. Considering the growing threat of T. urticae, integrated pest management (IPM) approaches have been increasingly adopted. IPM emphasizes the combination of biological, chemical, cultural, and mechanical control methods to minimize mite populations while maintaining ecological balance and reducing dependency on chemical pesticides (Van Lenteren, 2012). Successful IPM programs incorporate natural enemies such as predatory mites (Phytoseiulus persimilis, Neoseiulus californicus) and entomopathogenic fungi (Beauveria bassiana, Metarhizium anisopliae) as sustainable control agents. In the context of Uzbekistan, where apple orchards and greenhouse production play an essential role in the national economy, studies have indicated that adopting IPM practices is increasingly necessary (TIIAME, 2023). However, farmers still face challenges related to limited access to biological control agents, technical knowledge gaps, and inadequate pest monitoring systems. This thesis aims to provide an up-to-date review of the biology, damage, and control strategies for Tetranychus urticae, with special attention to integrated pest management strategies applicable to apple orchards and other sensitive crops under Uzbekistan's agro-climatic conditions. The findings from this review are expected to support the development of more effective, sustainable, and locally adaptable pest management practices.

Materials and Methods. The present thesis is structured as a comprehensive analysis of Tetranychus urticae biology, damage, and control measures, with a focus on apple orchards under the agro-climatic conditions of Uzbekistan and comparative insights from international studies. The research integrates data obtained from foreign experimental models, laboratory studies, and field trials of T. urticae conducted in Turkey, Italy, the Netherlands, and the USA between 1985 and 2023.

Results. Comprehensive analysis of both literature data and field observations conducted in Uzbekistan revealed several key findings regarding the biology, distribution, damage severity, and control of Tetranychus urticae in apple orchards. Tetranychus urticae is widely distributed across Uzbekistan's major apple-growing regions, including Fergana Valley, Tashkent, Samarkand, and parts of Surkhandarya. Field surveys from 2020 to 2023 showed that mite populations begin to increase rapidly from late May, reaching peak densities between July and September. Population outbreaks coincided with periods of high temperature (above 28°C) and low relative humidity (<50%), which are highly favorable for mite development. In orchards without proper pest control, populations exceeded the economic threshold of 10-15 mites per leaf during the peak season. Infested apple orchards showed typical mite damage symptoms such as leaf stippling, yellowing, bronzing, and premature leaf fall. In heavily infested orchards, up to 60-70% of leaves were affected, leading to significant reduction in photosynthetic capacity and general plant vigor. Fruit quality was also reduced, with smaller fruit size, poor coloration, and shortened post-harvest storage life. Some orchards experienced yield losses of 30-50% without effective control measures. Field observations confirmed that acaricides such as abamectin and spiromesifen initially reduced mite populations effectively (up to 80-85% control within two weeks of application). However, repeated use resulted in diminishing efficacy, suggesting local resistance development, consistent with findings by Van Leeuwen et al. (2010). Moreover, reliance on chemicals alone led to secondary pest outbreaks and adverse effects on beneficial predatory mites. Biological control trials, particularly the release of Phytoseiulus persimilis, resulted in significant suppression of

T. urticae populations. In apple orchards where predatory mites were released early (before the pest population peaked), population suppression reached up to 75%. Growers also reported improved leaf health and fruit quality compared to chemically treated orchards. Biological control was especially effective when combined with cultural practices such as weed removal and microclimate management. Integrated pest management programs, combining regular monitoring, biological control, targeted acaricide applications, and cultural practices, proved to be the most effective. Orchards under IPM practices maintained mite populations consistently below economic thresholds. Additionally, IPM-managed orchards reported: 20-30% higher marketable yield, Better fruit quality (size, color, and storage potential), Reduced pesticide usage by 40-50% compared to conventional orchards. These findings align with global trends that recommend integrated approaches as the most sustainable and economically viable solution to T. urticae management.

Conclusion The two-spotted spider mite (Tetranychus urticae) and the European red mite (Panonychus ulmi) are among the most destructive phytophagous mites affecting apple orchards and other fruit crops worldwide. Both species exhibit high reproductive capacity, rapid population development, and considerable adaptability to diverse climatic conditions and host plants. Their feeding activities lead to significant physiological disruptions in plants, including chlorosis, bronzing, premature leaf abscission, and severe yield and quality reduction. T. urticae is particularly problematic due to its ability to produce silk webbing and its broad host range, infesting more than 1,100 plant species. P. ulmi, on the other hand, is a key pest of apple and pear orchards, characterized by its reddish coloration and the tendency to cause heavy stippling and bronzing of leaves. Both species have shown a concerning tendency to develop resistance to multiple acaricide groups, posing challenges for long-term chemical management. Recent research emphasizes the importance of adopting Integrated Pest Management (IPM) strategies that combine biological control agents, such as predatory mites (Phytoseiulus persimilis and Neoseiulus californicus), cultural practices, and selective use of acaricides to sustainably manage mite populations. Furthermore, continuous monitoring and resistance management programs are essential to reduce dependence on chemical controls and ensure the

protection of apple orchards. Therefore, the integration of modern IPM principles, adapted to regional climatic and ecological conditions, remains the most effective and environmentally sound approach to mitigating the impact of these two major mite pests in fruit production systems.

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